DYREGROV ROBINSON INC.
Consulting Geotechnical Engineers

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Project: 163939

May 27, 2016

City of Winnipeg
Planning, Property & Development Department
Municipal Accommodations Division Project Services Branch
4th Floor, 185 King Street
Winnipeg, Manitoba R3B 1J1

Attention: John Atkinson, Project Officer

RE: Crescent Drive Park Pavilion
Geotechnical Investigation

As requested, Dyregrov Robinson Inc. (DRI) has undertaken a geotechnical investigation for the proposed pavilion project in Crescent Drive Park which is located at 756 Crescent Drive in Winnipeg, MB. The purpose of this investigation was to evaluate the subsurface conditions in order to provide geotechnical recommendations for design of foundations and floor slabs.

Proposed Development

The proposed development is understood to consist of multiple interconnected 4 season and covered 3 season elements including washroom facilities, fire place stations, patio areas, and a multi-purpose room. The development will be single storey, built at grade, and encompass approximately 212 m^2. We understand that the washroom and multi-purpose building areas (i.e. the 4 season elements) will be heated.

Site Conditions

The proposed pavilion will replaced the existing washroom facility at 756 Crescent Drive, within the Crescent Drive Park. The general site area is about 1 to 2 m higher than the surrounding area to the west, south and east. The ground north of the existing facility is similar in elevation to the site grade. The area is mainly vegetated with grass but there are a number of mature trees in the general area.

The existing washroom building and sidewalk / patio areas are generally in good condition and do not exhibit signs of significant seasonal movement. The foundation types used to support the building were not provided.

Field Investigation

Three test holes were drilled on March 9, 2016 at the locations shown on attached Figure 1. The test holes were drilled by Paddock Drilling Ltd. using an RM-30 track mounted drill rig equipped with 125 mm diameter solid stem augers. The test holes were drilled to depths of 11.2, 5.0 and 3.5 m below grade in Test Holes 1, 2 and 3, respectively. The subsurface conditions were visually logged during drilling by DRI.

Representative disturbed (auger cuttings and split barrel sampler) samples were collected from each test hole. Standard Penetration Tests (SPT's) were performed by driving a split barrel sampler 450 mm into the base of the test hole using an automatic slide hammer weighing 63.5 kg dropped from a height of 760 mm. The number of blows for every 150 mm of penetration was recorded. The SPT N value is the number of hammer blows required to drive the split barrel 300 mm after the initial 150 mm of penetration. The SPT-N values are shown on the test hole logs. All test holes were backfilled with auger cuttings and bentonite chips. All samples were taken to our Soils Testing Laboratory in Winnipeg for additional visual classification and testing to determine the moisture contents on all samples. The test hole logs are attached in Appendix A and include a description of the subsurface conditions encountered, the results of the laboratory testing, and notes regarding the observations made during drilling.

Subsurface Conditions

The soil profile encountered in the test holes consists of a thin surficial layer of sand and gravel or topsoil fill overlying alluvial sand and clay deposits. The ground was frozen to a depths of 0.6 to 0.8 m at the time of drilling. The soil stratigraphy encountered was different than expected based on local experience which suggested that alluvial clay soils would be present at the site.

Sand and gravel fill was encountered from surface in Test Holes 1 and 2 and was 50 mm thick. A 50 mm thick layer of black topsoil was encountered from surface in Test Hole 3.

A 1.45 m thick clay layer was encountered beneath the sand and gravel fill in Test Hole 3. The clay is silty, black, and moist with high plasticity. The moisture content of the clay is around 25 percent.

A sand layer was encountered in Test Holes 1 and 3 below the sand and gravel fill. The sand is 5.5 m thick in Test Hole 1 and 1.5 m thick in Test Hole 3. The sand is silty, brown, dry and loose to compact. The moisture content ranges from 6 to 12 percent and the Standard Penetration Test (SPT) N values from 5 tests ranged from 7 to 13 with an average around 10.

A clayey sand layer was encountered at depths of 5.5, 1.5, and 1.5 m in Test Holes 1, 2 and 3, respectively. The sand is brown and moist with the colour turning to grey below 7.3 m in Test Hole 1. The moisture contents ranged from around 6 to 28 percent, with an increased moisture content of 34 percent being determined in a suspected 150 mm thick clay layer at 9.1 m below grade in Test Hole 1. In-situ SPT testing yielded SPT N-values ranging from 6 to 10 indicating a loose condition.

No seepage was observed in the test holes during drilling. Some sloughing was observed in Test Hole 1, with it remaining open to 6.1 m below grade after drilling to a depth of 11.2 m. No sloughing was observed in Test Holes 2 and 3. Groundwater conditions should be expected to vary seasonally, from year to year and possibly as a result of construction activities.

Discussion and Recommendations

Based on the subsurface conditions encountered in the test holes, the recommended foundation types are spread footings and helical piles. Cast-in-place concrete friction piles where the preferred foundation type for the project, however due to the soil stratigraphy consisting primarily of non-cohesive granular soils as opposed to the anticipated alluvial clay, this foundation type is not considered to be feasible.

Spread Footings

Rectangular spread footings and continuous strip footings bearing on loose to compact sand can be sized with a Service Limit State (SLS) bearing pressure of 75 kPa and a factored Ultimate Limit State (ULS) bearing pressure of 110 kPa. A resistance factor of 0.5 was used to calculate the factored ULS bearing resistance. Settlement of the footings under service loads are expected to be 25 mm or less. The settlements are expected to occur fairly quickly as the dead load is applied. Some seasonal movement of the footings should be expected.

The footings should be installed 1.8 m below grade and have a minimum width of 760 mm.

The seasonal frost penetration depth in the Winnipeg area is approximately 2.5 m. Spread footings that are installed less than 2.5 m below existing site grade and are subjected to freezing conditions must be protected from potential frost heave effects by placing rigid insulation, such as Styrofoam HI, to minimize frost penetration into the soil around and below the footings. A minimum insulation thickness of 50 mm is recommended. Horizontal insulation sheets should be placed with a minimum soil cover of 500 mm and extend at least 1.2 m out from the perimeter of the building. A vertical sheet of insulation should be installed above the horizontal sheet up to the insulated wall of the building. The vertical insulation should be attached to the exterior wall.

The bearing surfaces should be manually cleaned to remove all loose and deleterious materials from the bearing surface.

The bearing surfaces should be protected at all times from climactic conditions (i.e. freezing, wetting, drying, etc.). The concrete must not be placed on frozen soil and the bearing surfaces should not be allowed to freeze after the footings have been installed. The footing excavations must be maintained in a dry condition at all times.

The footing excavations should be backfilled with the excavated material removed during excavation for the footings. The backfill should be uniformly compacted to 95 percent of the Standard Proctor Maximum Dry Density (SPMDD).

Helical Screw Piles

Helical screw piles can be considered to support the proposed structure. The pile supplier should determine the screw pile configuration to support the design loads and provide a shop drawing, sealed by a Professional Engineer licensed to practice in the Province of Manitoba, with pile capacity calculations. The test hole information provided in this geotechnical report for the proposed pavilion development can be used by the pile supplier, however it should be recognized that soil conditions are inherently variable and that the test holes were advanced at random locations on the site. Additionally, all configurations should be in adherence to the Information Bulletin 2006-001-S, "Acceptance of Augered Piles" issued by the City of Winnipeg of May 6, 2016. Load testing of the helical screw piles could be considered to confirm the pile capacity meets the design requirements.

Floor Slabs

Floor slabs on grade can be considered. Movements of floor slabs on grade are likely to occur over time, particularly in the three season elements of the facility. Vertical movements on the order of 25 to 50 mm could occur over time. The movements can be differential and are not expected to be uniform across the floor slab. Floor slabs that are in unheated areas could be insulated below and around the slab to minimize frost penetration into the ground and help protect the slab against seasonal movements. The insulation should be placed on the prepared subgrade and extend at least 1.8 m beyond the perimeter of the slab. A minimum soil cover of 400 mm is recommended.

Slab-on-grade floors could be isolated from fixed building components (e.g. grade beams) in an effort to allow for some floor slab movements to occur without affecting the structure. A vapour barrier should be provided below the floor slab. The floor slab should not be placed against frozen soil and should be supported on 200 mm of compacted granular base material placed on a prepared subgrade. The granular base should be a 19 mm down crushed limestone material compacted to 98 percent of the SPMDD. The subgrade should be graded smooth, scarified to a depth of about 150 mm and then uniformly re-compacted to 95 percent of the SPMDD at the optimum moisture content.

Fire Pit and Barbeque Stations

Provided the fire pit and barbeque stations can tolerate some seasonal movement, they can be supported on a slab on grade foundation. The slab should not be placed against frozen soil and should be supported on 200 mm of compacted granular base material placed on a prepared subgrade. The granular base should be a 19 mm down crushed limestone material compacted to 98 percent of the Standard Proctor Maximum Dry Density (SPMDD). The subgrade should be graded smooth, scarified to a depth of about 150 mm and then uniformly re-compacted to 95 percent of the SPMDD at the optimum moisture content.

Excavations

All excavation work should be completed by the Contractor in accordance with the current Manitoba Workplace Health and Safety Regulations to suit the planned and expected construction activities and schedule.

Other

Positive drainage should be provided away from all structures at gradients of at least 2 percent.

We recommend that the potential for sulphate attack be considered as moderate (Exposure Class S-3). All concrete in contact with clay soil should be made with sulphate resistance cement (Type HS) in accordance with the Building Code and relevant CSA standards.

A 100 mm thick void form should be provided beneath all grade beams.

Closure

This report and its findings were prepared based on the subsurface conditions encountered in the random test holes drilled on 9 March 2016 for the sole purpose of this geotechnical investigation and our understanding of the proposed development at the time of this report. Subsurface conditions are inherently variable and should be expected to vary across the site.

This report was prepared for the sole and exclusive use of the City of Winnipeg for the proposed pavilion development in Crescent Drive Park located in Winnipeg, Manitoba. The information and recommendations contained in this report are for the benefit of the City of Winnipeg only and no other party or entity shall have any claim against the author nor may this report be used for any other projects, including but not limited to changes in this proposed development without the consent of the author. The findings and recommendations in this report have been prepared in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, expressed or implied, is provided.

Please contact us if we can be of further assistance.

Sincerely,

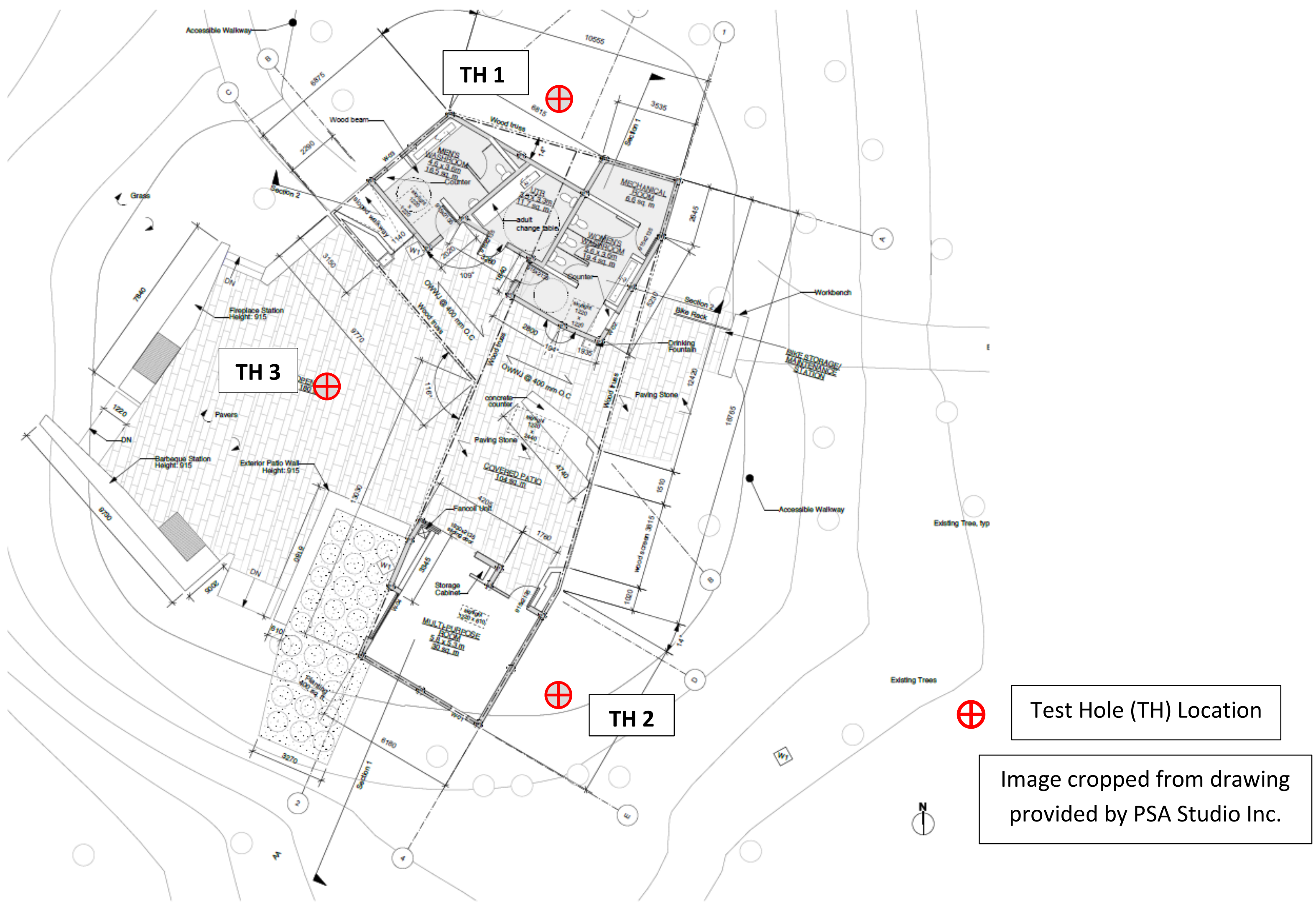
DYREGROV ROBINSON INC.

Henry Papst, P.Eng. (Alberta)
Geotechnical Engineer

Gil Robinson, M.Sc., P.Eng.
President / Senior Geotechnical Engineer

PROVINCE OF MANITOBA
G.G.B.
ROBINSON
27 May 2016
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
Dyregrov Robinson Inc.
No. 86 Date: 27 May 2016



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Proposed Pavilion Development – Crescent Drive Park
Test Hole Location Plan

SCALE:	MADE BY:	CHKD BY:	PROJECT NO.	DATE:	
NTS	HP	GR	163939	April 2016	**FIGURE 1**

APPENDIX A

Test Hole Logs

EXPLANATION OF TERMS & SYMBOLS

Description				TH Log Symbols	USCS Classification	Laboratory Classification Criteria: Fines (%)	Grading	Plasticity	Notes
COARSE GRAINED SOILS	GRAVELS (More than 50% of coarse fraction of gravel size)	CLEAN GRAVELS (Little or no fines)	Well graded gravels, sandy gravels, with little or no fines		GW	0-5	$C_U > 4$ $1 < C_C < 3$		
			Poorly graded gravels, sandy gravels, with little or no fines		GP	0-5	Not satisfying GW requirements		Dual symbols if 5-12% fines. Dual symbols if above "A" line and $4 < W_P < 7$
		DIRTY GRAVELS (With some fines)	Silty gravels, silty sandy gravels		GM	> 12		Atterberg limits below "A" line or $W_P < 4$	
			Clayey gravels, clayey sandy gravels		GC	> 12		Atterberg limits above "A" line or $W_P < 7$	
	SANDS (More than 50% of coarse fraction of sand size)	CLEAN SANDS (Little or no fines)	Well graded sands, gravelly sands, with little or no fines		SW	0-5	$C_U > 6$ $1 < C_C < 3$		$C_U = \frac{D_{60}}{D_{10}}$
			Poorly graded sands, gravelly sands, with little or no fines		SP	0-5	Not satisfying SW requirements		$C_C = \frac{(D_{30})^2}{D_{10} x D_{60}}$
		DIRTY SANDS (With some fines)	Silty sands, sand-silt mixtures		SM	> 12		Atterberg limits below "A" line or $W_P < 4$	
			Clayey sands, sand-clay mixtures		SC	> 12		Atterberg limits above "A" line or $W_P < 7$	
FINE GRAINED SOILS	SILTS (Below 'A' line negligible organic content)	$W_L < 50$	Inorganic silts, silty or clayey fine sands, with slight plasticity		ML			Classification is Based upon Plasticity Chart	
		$W_L > 50$	Inorganic silts of high plasticity		MH				
	CLAYS (Above 'A' line negligible organic content)	$W_L < 30$	Inorganic clays, silty clays, sandy clays of low plasticity, lean clays		CL				
		$30 < W_L < 50$	Inorganic clays and silty clays of medium plasticity		CI				
		$W_L > 50$	Inorganic clays of high plasticity, fat clays		CH				
	ORGANIC SILTS & CLAYS (Below 'A' line)	$W_L < 50$	Organic silts and organic silty clays of low plasticity		OL				
		$W_L > 50$	Organic clays of high plasticity		OH				
HIGHLY ORGANIC SOILS			Peat and other highly organic soils		Pt	Von Post Classification Limit		Strong colour or odour, and often fibrous texture	

	Asphalt		Glacial Till		Bedrock (Igneous)
	Concrete		Clay Shale		Bedrock (Limestone)
	Fill				Bedrock (Undifferentiated)

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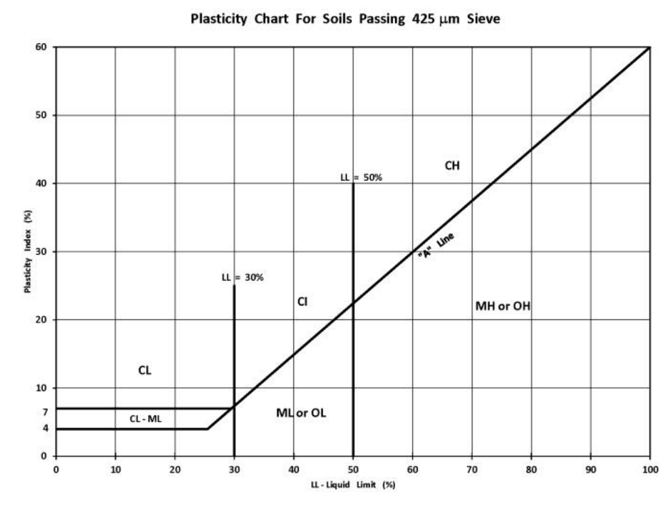


FRACTION		**PARTICLE SIZE** (mm) Min.	Max.
Boulders		>300	
Cobbles		75	300
Gravel	Coarse	19	75
	Fine	4.75	19
Sand	Coarse	2.0	4.75
	Medium	0.425	2.0
	Fine	0.075	0.425
Silt (non-plastic) or Clay (plastic)		< 0.075 mm	

RELATIVE PROPORTIONS (by weight)	
Percent	Descriptor
>35%	main fraction
35 - 50	"and"
20 – 35	Adjective e.g. silty, clayey
10 – 20	"some"
1 - 10	"trace"

Soil Classification Example

Clay 50% (main fraction), Silt 25%, Sand 17%, Gravel 8%

Clay – silty, some sand, trace gravel

TERMS and SYMBOLS

Laboratory and field tests are identified as follows:

Unconfined Comp.: undrained shear strength (kPa or psf) derived from unconfined compression testing.

Torvane: undrained shear strength (kPa or psf) measured using a Torvane

Pocket Pen.: undrained shear strength (kPa or psf) measured using a pocket penetrometer.

Unit Weight bulk unit weight of soil or rock (kN/m^3 or pcf).

SPT – N Standard Penetration Test: The number of blows (N) required to drive a 51 mm O.D. split barrel sampler 300 mm into the soil using a 63.5 kg hammer with a free fall drop height of 760 mm.

DCPT Dynamic Cone Penetration Test. The number of blows (N) required to drive a 50 mm diameter cone 300 mm into the soil using a 63.5 kg hammer with a free fall drop height of 760 mm.

M/C insitu soil moisture content in percent

PL Plastic limit, moisture content in percent

LL Liquid limit, moisture content in percent

The undrained shear strength (Su) of cohesive soil is related to its consistency as follows:

Su (kPa)	Su (psf)	CONSISTENCY
<12	250	very soft
12 – 25	250 – 525	soft
25 – 50	525 – 1050	firm
50 – 100	1050 – 2100	stiff
100 – 200	2100 – 4200	very stiff
200	4200	hard

The SPT - N of non-cohesive soil is related to compactness condition as follows:

N – Blows / 300 mm	COMPACTNESS
0 - 4	very loose
4 - 10	loose
10 - 30	compact
30 - 50	dense
50 +	very dense

References:

ASTM D2487 – Classification of Soils For Engineering Purposes (Unified Soil Classification System)

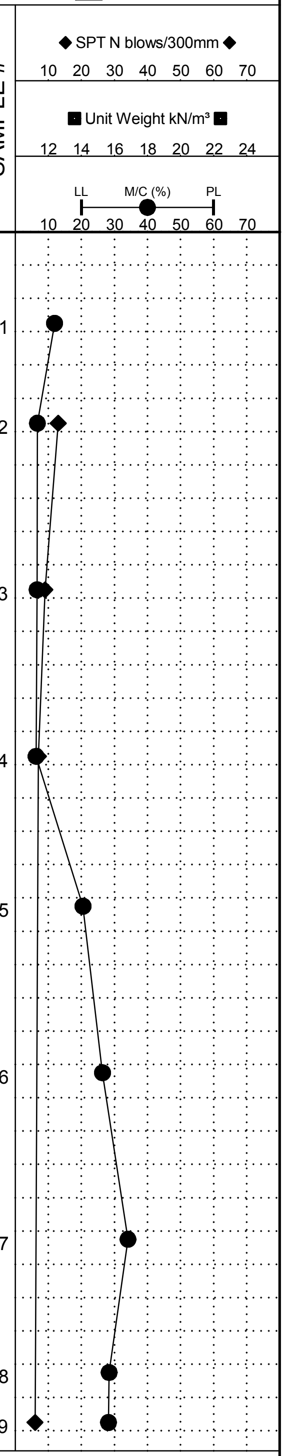
Canadian Foundation Engineering Manual, 4th Edition, Canadian Geotechnical Society, 2006

PROJECT: Crescent Drive Park Pavilion	CLIENT: City of Winnipeg	TEST HOLE NO: **1**
LOCATION: North of existing washroom facility		PROJECT NO.: 163939
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM - 30 Drill Rig with 125 mm Solid Stem Augers	ELEVATION (m):

SAMPLE TYPE: GRAB, SHELBY TUBE, SPLIT SPOON, BULK, NO RECOVERY, CORE

BACKFILL TYPE: BENTONITE, GRAVEL, SLOUGH, GROUT, CUTTINGS, SAND

DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #
0	SAND AND GRAVEL (FILL) - brown, moist		
	SAND (alluvial) - silty - light brown - loose to compact, dry	GRAB	G1
		SPLIT SPOON	S2
		SPLIT SPOON	S3
	- sand moist below 4.6 m	SPLIT SPOON	S4
	SAND (alluvial) - clayey - light brown, moist, loose	GRAB	G5
	- grey below 7.3 m	GRAB	G6
	- suspected clay layer approximately 150 mm thick at 9.1 m	GRAB	G7
		GRAB	G8
		SPLIT SPOON	S9



END OF TEST HOLE AT 11.2 m IN SAND

NOTES:

1. After drilling hole open to 6.1 m from top of hole and no seepage.
2. Test hole backfilled with auger cuttings and bentonite.
3. Ground frozen to a depth of 0.8 m at time of drilling.

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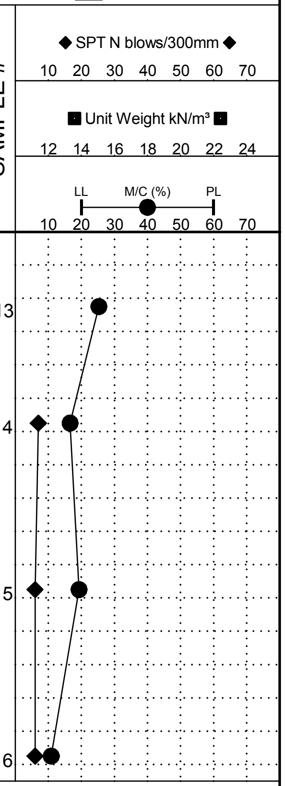
LOGGED BY: WG	COMPLETION DEPTH: 11.16 m
REVIEWED BY: GR	COMPLETION DATE: 9/3/16
PROJECT ENGINEER: Gil Robinson	Page 1 of 1

PROJECT: Crescent Drive Park Pavilion		CLIENT: City of Winnipeg	TEST HOLE NO: **2**
LOCATION: 2 m north and 3 m west of south west corner of concrete pad			PROJECT NO.: 163939
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM - 30 Drill Rig with 125 mm Solid Stem Augers		ELEVATION (m):

SAMPLE TYPE	GRAB	SHELBY TUBE	SPLIT SPOON	BULK	NO RECOVERY	CORE
BACKFILL TYPE	BENTONITE	GRAVEL	SLOUGH	GROUT	CUTTINGS	SAND

ELEVATION (m)	DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #
	0		SAND AND GRAVEL (FILL) - brown, moist		
			CLAY (alluvial) - silty - black, moist - high plasticity	GRAB	G13
			SAND (alluvial) - clayey - brown, moist, loose	SPLIT SPOON	S14
				SPLIT SPOON	S15
	5			SPLIT SPOON	S16



END OF TEST HOLE AT 5.0 m IN SAND

NOTES:

1. After drilling no seepage or sloughing observed.
2. Test hole backfilled with auger cuttings and bentonite.
3. Ground frozen to a depth of 0.8 m at time of drilling.

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Consulting Geotechnical Engineers

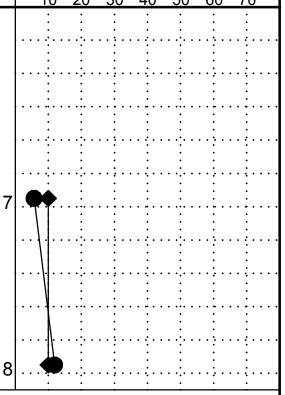
LOGGED BY: WG	COMPLETION DEPTH: 5.03 m
REVIEWED BY: GR	COMPLETION DATE: 9/3/16
PROJECT ENGINEER: Gil Robinson	Page 1 of 1

PROJECT: Crescent Drive Park Pavilion	CLIENT: City of Winnipeg	TEST HOLE NO: **3**
LOCATION: 7.5 m south from existing concrete pad		PROJECT NO.: 163939
CONTRACTOR: Paddock Drilling Ltd.	METHOD: RM - 30 Drill Rig with 125 mm Solid Stem Augers	ELEVATION (m):

SAMPLE TYPE	GRAB	SHELBY TUBE	SPLIT SPOON	BULK	NO RECOVERY	CORE
BACKFILL TYPE	BENTONITE	GRAVEL	SLOUGH	GROUT	CUTTINGS	SAND

ELEVATION (m)	DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #
	0		TOPSOIL - organics, black		
			SAND (alluvial) - silty - brown, dry, loose		
	1				
			SAND (alluvial) - clayey - brown, moist, loose to compact - thin layers of clay within the sand	Split spoon	S17
	2				
	3			Split spoon	S18

◆ SPT N blows/300mm ◆ (10 20 30 40 50 60 70)
■ Unit Weight kN/m³ ■ (12 14 16 18 20 22 24)
LL — M/C (%) — PL (10 20 30 40 50 60 70)



END OF TEST HOLE AT 3.5 m IN SAND
NOTES:
1. After drilling no seepage or sloughing observed.
2. Test hole backfilled with auger cuttings and bentonite.
3. Ground frozen to a depth of 0.6 m at time of drilling.

DYREGROV ROBINSON INC. Consulting Geotechnical Engineers	LOGGED BY: WG	COMPLETION DEPTH: 3.51 m
	REVIEWED BY: GR	COMPLETION DATE: 9/3/16
	PROJECT ENGINEER: Gil Robinson	Page 1 of 1